UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Washington, D. C. 20250

March 11, 1965

Advisory ENG-13

From: C. J. Francis, Director, Engineering Division

Re: ENG - Technical Releases No. 26 and No. 27

Attached are (1) Technical Release No. 26 "The Use of Soils Containing More Than 5 Percent Rock Larger Than The No. 4 Sieve," and (2) Technical Release No. 27 "Laboratory and Field Test Procedure for Control of Density and Moisture of Compacted Earth Embankments" with its Appendix "Details on Construction Control Tests for Rocky Soils in Compacted Earth Embankments."

The material contained in these Technical Releases is included in National Engineering Handbook No. 19, Construction Inspection, which will be distributed to you soon. Technical Release No. 26 will be found interspersed in Chapter 3. Technical Release No. 27 and its Appendix are included, intact, in Chapter 4.

We are sending them to you now, as a separate, for greater ease of study and understanding.

Because the procedures outlined in these releases will provide more positive control and more predictable results in investigation, design and construction, we recommend their immediate use. These principles have been used on some jobs this past year and they should be used on all important jobs by construction year 1966. The "rock correction" method of determining moisture-density relationships will be abandoned as you base your investigation, design and construction control on the procedures outlined in Technical Release No. 26.

Additional copies of TR-26 and TR-27 may be obtained as described in Engineering Memorandum 20.

Attachments

John T. Phelan
ACTING

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United States Department of Agriculture
Soil Conservation Service
Engineering Division

Technical Release No. 26

December 1964

THE USE OF SOILS CONTAINING MORE THAN 5 PERCENT ROCK LARGER THAN THE NO. 4 SIEVE

Introduction

The purpose of this technical release is to furnish guidance on procedures to be followed in sampling, testing, and construction control of soils containing more than 5 percent rock larger than the No. 4 size which are to be used for earth fills. Utilizing these materials properly and economically presents many problems.

The moisture-density relationships and resultant strength, compressibility and permeability of rocky soils after compaction in an embankment are considerably influenced by the amount and gradation of the rock fraction. The final gradation of the material as placed will depend upon the resistance of the rock to breakdown and disintegration by mechanical manipulation and natural weathering.

One of the most important problems involved in the proper use and construction control of rocky materials is the determination of gradation and density that should be used in the laboratory testing program. Design values for strength and permeability should be based on specimens that possess characteristics representing those of the material when compacted in an earth fill.

The selection of engineering properties for design purposes can be approached in either of two ways:

1. The preferred approach is to perform laboratory tests on specimens with gradation and density conforming to the values obtained from samples taken from test fills built by using specified construction procedures.

2. An alternate approach is to perform laboratory tests on specimens for which the gradation and density are established based on past experience with similar materials. This requires evaluation of the gradation and density of the fill as it is being placed in order to determine the need for re-evaluating the design of the structure.

When strength and permeability are critical, construction specifications may require that construction procedures be adjusted to produce an earth fill having characteristics comparable with those of the specimens used in the testing program. This procedure may be required when materials with rock fractions subject to breakdown and disintegration during placement and compaction are to be used in critical sections of the earth fill, but can generally be avoided by using procedures outlined in above approach No. 1.

The problem of determining grading and density characteristics for use in laboratory test specimens is most difficult for: (1) Materials with rocks larger than 3 inches since this is the maximum particle size that can be included in laboratory test specimens, and (2) materials with rocks that break down during placement and compaction of the fill.

The degree to which the rock particles in the soil mass will break down when the soil is compacted will vary with the size of the rock fraction, the nature of the rocky material, moisture content, gradation before compaction, thickness of lift, compactive effort, and the type of compaction equipment used. It is impossible to predict the gradation and density of the material that will result from compaction without detailed observations of the properties of samples before and after compaction, considering all conditions affecting the results, together with tests on undisturbed test cores from test fills or sections of earth fills under construction.

Unfortunately very little information on these materials is presently available. Basic data on the breakdown characteristics of the rock and the density resulting after compaction in an earth fill are essential for developing a laboratory testing program to determine practical and safe design values.

Another problem involved with the use of coarse-grained soils concerns methods and difficulties of conducting embankment construction control tests. This is a major problem when dealing with soft shales or very plastic GC materials due to difficulties in physically separating specific sizes of materials.

A third problem related to use of these materials involves investigation, sampling and identification. This problem is especially critical with material containing soft rocks that break down during construction operations. Classification and identification properties must be correlated with observation of properties after compaction in order to develop criteria for predicting the physical behavior of these materials.

It is evident, in light of the foregoing discussion of problems involved in the use of rocky materials, that guide procedures presented in this release are subject to many changes. A concerted effort must be made

to correlate investigational procedures, laboratory testing, construction performance and end product characteristics. Practical revisions and additions to the proposed guides cannot be made without cataloging experience history; accumulating and evaluating construction performances; constructing and sampling test fills; and testing and evaluating completed embankments in an orderly and systematic fashion.

I. Description of Materials Involved

For purposes of this release, Rock or Rock Fraction (plus 4 fraction) refers to those particles in an earth mass larger than No. 4 sieve (4.76 mm. or approximately 3/16" diameter), consisting of unaltered fragments of mineral solids that have retained the structure and composition of natural geologic formations. Soil or Soil Fraction (minus 4 fraction) is the portion of an earth mass smaller than No. 4 sieve consisting of individual particles derived from physical and chemical weathering of rocks and minerals.

Soils containing rock maybe placed into three categories based upon durability and resistance to physical breakdown and upon plasticity of rock materials when pulverized.

Group I - Durable Rock: The rock will not break down or disintegrate significantly during excavation and compaction operations or from the action of natural weathering processes. (Moh's hardness scale of plus 4)

Group II - Moderately Durable Rock: The rock will break down into smaller sizes during excavation and compaction operations but can be separated from the soil by wet sieving methods without further breakdown. The rock would include moderately soft to hard sandy shales, siltstones, moderately weathered granite, gneiss, schist, slate, cherty limestone, marble, etc, (Moh's hardness scale of plus 2, 3 or 4). The dry unit weight of the rock will generally be greater than 110 p.c.f. Pulverized rock materials will have low plasticity with PI values less than 15.

Group III - Non-Durable Rock: The rock breaks down easily into smaller size particles during excavating and compacting operations and is not sufficiently durable or stable under the action of water to be separated from the soil fraction without further breakdown. Each manipulation during attempts to determine gradation of the soil mass results in further breakdown of the rock into smaller

sizes. In many cases, the rock is less dense and softer than the soil after compaction. Rock in this group includes very soft to soft plastic clay shales, highly weathered to moderately weathered clayey siltstones, soft limestones, schists, etc., (Moh's hardness scale of 2 or less). The dry unit weight of the rock will generally be less than 110 p.c.f. Pulverized rock material will generally have PI values greater than 15.

II. Design and Construction Control Procedures

The following procedures are recommended for use in testing, design and construction control. These procedures are based upon consideration of the influence of the plus 4 fraction and on the engineering properties of the total soil mass.

The engineering properties (shear strength, consolidation, and permeability) of compacted materials with more than 65 percent passing the No. 4 sieve are generally controlled by the characteristics of the minus 4 fraction. Rock larger than the No. 4 sieve has little effect on engineering properties of the total soil mass in amounts less than 35 percent.

The engineering properties of compacted materials with 35 percent to 65 percent passing the No. 4 sieve are significantly affected by both the compacted characteristics of the minus 4 fraction and the size, amount, gradation, and character of the plus 4 fraction.

When materials are so coarse that less than 35 percent passes the No. 4 sieve, there are generally not enough finer particles to fill the voids and engineering properties are related to placement conditions and overall density of the mass.

Group I - Durable Rock.

A. Materials with 65% or more passing No. 4 sieve: (35% or less rock)

Design.--Testing and design will be based upon the engineering properties of the fill matrix (minus No. 4 or 3/4" fraction).

Control.--The construction contract will specify moisture and compaction requirements for the fill matrix. All field moisture-density tests and embankment density tests will be performed on the fill matrix.

Note: The fill matrix is defined as that fraction of the fill material having a maximum size equal to that used in the compaction test method.

When a fill matrix with plastic fines approaches the maximum rock content (35% ▷ No. 4), physical separation of the fraction may be difficult and time-consuming. It may be desirable to establish methods of placement and compaction from test fills in order to reduce the number of construction control tests to a minimum. Materials of this type (SC & GC) are prime construction materials and should present few compaction problems.

B. Materials containing 35% to 65% passing No. 4 sieve: (35-65% rock) Materials of this type present many unanswerable questions relative to testing specimens that truly represent the completed embankment. The following approach should produce results that are on the safe side:

Testing and Design.--Design will be based on the properties of either the total sample (mass) or the minus 3/4" fraction (fill matrix). When natural borrow sources are quite variable with rock contents covering the entire range of 35% to 65% rock laboratory tests and design will be based on the characteristics of the material in the least desirable condition of rock content. Specifications can then call for random fill from the specified borrow sources.

Control.--The construction contract may specify either methods of construction or the moisture and density requirements for the minus 3/4" fraction. When moisture and density are specified, embankment compaction will generally be controlled on the basis of field moisture-density (Proctor) tests performed on the minus 3/4" material taken from the same location as embankment density tests.

It may be desirable to use method specifications for materials with plastic fines due to difficulty in making physical separation of particle sizes. This procedure will require close inspection and careful evaluation of methods of compaction and occasional embankment density tests to insure fulfillment of minimum design requirements.

C. Material with less than 35% passing No. 4 sieve: (65% rock) Laboratory tests will not generally be performed on these materials. Design will be based upon engineering properties of the mass developed by special testing and correlative experience with similar materials. The construction contract will specify the method the contractor will follow in placing and compacting these materials. Method specifications may be developed in a manner to permit changes in procedures to assure production of an end product that fulfills design requirements as determined by tests of the mass density of the compacted embankment.

Group II - Moderately Durable Rock.

These materials will disintegrate or break down during normal placement and compaction operations, but the gravel fractions are hard and resistant enough to allow physical separation of various particle sizes without significant breakdown.

Design and compaction control will depend upon the ultimate breakdown of these materials after compaction on the fill. The breakdown characteristics of these materials will be determined by field engineers on the basis of test fills or documented experience with similar materials. This information will be transmitted in the investigational report and will serve as basis for setting up the testing program.

A & B. Material with more than 35% passing No. 4 sieve after compaction: The choice of design criteria, construction methods and construction control procedures should be based on the performance of test fills when these materials are considered for use in an important portion of unusually large structures, relatively hazardous embankments, and other relatively important or critical structures.

For those structures in which Group II materials will make up an unimportant portion of the total embankment and for those of low hazard or relatively less importance, design and control will be based on the compacted density of the mass. Percentage of breakdown may be required to fulfill design requirements for strength, impermeability or other properties.

C. Material with less than 35% passing the No. 4 sieve after compaction: Design will be based upon engineering properties of the mass as determined from special tests and correlative experience. Placement and compaction will be controlled by method specifications with some tests for mass density to assure an end product of desired quality.

Group III - Non-Durable Rock.

The separation of rock and soil fractions after these materials have been compacted cannot be done in the field with any degree of consistency.

Predictions regarding breakdown and compacted characteristics of these materials will be made by the field engineer on the basis of test fills or documented experience with similar materials. This information will be transmitted in the investigational report.

Test fills will generally be required to evaluate breakdown and compaction characteristics and to develop design properties and construction specifications when these materials are to be used for an important portion of relatively large, important and/or hazardous structures.

Design and compaction control will be based upon mass density in accordance with results of laboratory tests covering a range of breakdown and densities when test fill information is not available.

III. Investigational and Sampling Requirements

The investigation and sampling of rocky materials to be used for embankment construction shall be done by means of test pits and other open excavations whenever practicable. Investigations and sampling of shale or other materials subject to disintegration and breakdown by exposure and weathering shall be done by means of excavated pits or freshly exposed outcrops.

Group I - Durable Rock.

The investigational report should include the following features:

1. Complete description of the deposit including geologic history, nature of deposition, degree of weathering, source of materials, mineralogy of the rock fraction, nature and causes of cementation (if applicable).

2. Approximate gradation of total material based on proportions passing 6", 3", 1-1/2", 3/4" and No. 4 sieves and information on the range of variability in amount of rock expected for each borrow source. The maximum size of rock expected in each borrow source should be noted.

3. Quantities of materials represented by each borrow source investigated and/or sample submitted for testing (these data should be shown on the sample list, Form SCS-534).

4. Engineering report on correlative experience and history on use of similar materials relative to compaction problems, compacted densities, and long-time durability. This should include construction experience other than SCS when available.

Samples submitted for testing should consist of materials smaller than 3" (with estimate of amounts larger than 3" not included in sample) in the following amounts:

For soils with 65% or more passing No. 4 = 50 pounds

For soils with 35% to 65% passing No. 4 = 250 pounds.

For soils with less than 35% passing No. 4, samples for testing will not generally be required. Samples and tests may be required when large amounts of these very coarse materials are proposed for use in embankments and when these materials are to be used in sections of the embankment where density, shear strength, and/or permeability values are needed for design. Two hundred and fifty (250) pound samples should be submitted when required.

Groups II and III - Materials with Rocks that Break Down during Compaction Processes.

At the present time, there is not sufficient correlation of physical properties and breakdown characteristics to provide guidance for predicting construction performance of these materials.

Investigational reports should include detailed information on the materials that break down, covering the following features:

1. Complete geologic description of the materials to include age, formation, member, mode of formation, and stress history.

2. Classification and identification of materials using the following guides:

   a. Hardness at natural moisture and at saturation.
   b. Estimated plasticity: (PI = $\pm$ 15).
   c. Bulk density (Bulk G_s).
   d. Structure: Platy, blocky, nature of bedding, fractures, etc.
   e. Texture.
   f. Porosity and permeability (estimated).
   g. Water stability: Degree of slaking on:
      (1) Freshly exposed 2" - 3" cubical pieces, and
      (2) Cupful of particles between 1/4" and 3/4" size. (Procedure for water stability determination to be appended.)
   h. Significant mineralogy of coarse materials including qualitative evaluation of clay minerals.
   i. Acidity or alkalinity.
   j. Soluble salt content.
   k. Any other significant identification feature.

3. Geologic weathering history of materials, nature of weathering products, time-weathering relationships, etc.

4. Correlation of properties with similar materials that have been identified and used in other locations. Correlation should not be restricted to materials of same age and formation.

5. Engineering report showing expected size characteristics of materials as they will be spread on the fill and the expected breakdown and compactability of material based upon previous experience with similar materials. This report should include information on equipment and methods used to handle similar materials and suggested for use on the project under consideration. Information on probable need for and use of water to supplement natural moisture will be important in evaluating breakdown and compaction characteristics of degradable materials.

Samples.--All samples of moderately durable and non-durable materials should be protected from changes in natural moisture content during all phases of collection, storage, and transportation.

The following amounts of material should be submitted for testing:

Group II - Moderately durable rock.--300 pounds of materials classed as moderately soft to hard, low plasticity, relatively water stable. Samples for testing may not be required for soils with less than 35% passing No. 4 after compaction. Samples and tests will be required if these materials are proposed for use in the major portion of the embankments or in sections of the embankment where specific values for density, shear strength, and/or permeability are needed for design, or in sections where long-time degradation by saturation or weathering may affect stability of the structure.

Group III - Non-durable rock.--150 pounds of materials classed as soft, plastic, not stable in water. When non-durable materials proposed for use in embankments occur at such depths that they must be investigated and sampled by means of mechanical coring, every effort should be made to correlate the deep deposits with other accessible deposits so that required amounts of samples from coring operations can be reduced.

Materials consisting of shales and other formations with interbedded hard and soft degradable materials should be investigated and sampled in accordance with foregoing procedures for the kind of material expected to dominate design and construction features.

IV. Evaluation of Material Performance

Answers to most of the problems dealing with testing, design and construction control of rocky materials can only be developed from detailed field studies and laboratory tests on samples from constructed embankments. Such studies should relate: (1) identification and classification properties and gradation characteristics of materials as they are excavated and spread on the fill; (2) gradation, density and other engineering properties after they have been compaced in the embankment and (3) detailed descriptions of equipment and procedures used in all embankment placement operations.

Evaluation studies may be conducted on test fills constructed during the investigational stage as a basis for testing and design; on embankments already designed and being constructed; and on completed structures.

Construction of test fills and detailed evaluation studies including collection of undisturbed cores will generally be required during the detailed site investigations to provide data for the design of structures to be built with shales and other materials that break down during compaction operation. This is especially true for large, high hazard dams.

Evaluation studies on embankments under construction may be required to verify design values not based on specific test fill data. Special studies during the construction stage should also be considered when materials at a given site are representative of those to be used in a significant volume of future construction.

Long term (10 ± years) studies on completed embankments will be required to evaluate the durability and weathering characteristics of Group II and III materials.

Detailed plans for evaluation studies should be developed and carried out with assistance and consultation of EWP Unit and Soil Mechanics Laboratory personnel.

An example of plans developed for one area is attached.

Laboratory testing of samples from evaluation study projects will be done at the Lincoln SML unless otherwise specified. The Soil Mechanics Laboratory will serve as coordinating office for collecting and analyzing data from evaluation and follow-up studies.

EXAMPLE

Procedure for Evaluating Use and Performance of "Rocky" Soils

I. Introduction:

This supplement to the Engineering Technical Release on "Use of Materials With More Than 5% Larger Than No. 4 Sieve Size," hereafter termed "rocky soils," presents details on information and samples to be obtained for studies in the area serviced by Fort Worth EWP Unit.

Sites selected for current evaluation are now under construction or proposed for construction in the near future. These sites were investigated prior to preparation of the Technical Release. Some of the information requested in this guide for evaluation studies should normally be collected during the site investigation and need not be duplicated in future evaluation studies when available from investigational reports.

All data and samples collected on these studies will be sent to the SML, Lincoln, Nebraska, for analysis and correlation of results on a nationwide basis.

Moisture losses from all samples should be minimized in all phases of the study. Those samples submitted for testing should be placed in moisture-proof bags as soon after collection as possible.

II. Detailed procedures for Evaluating Use of Different Types of Materials:

A. There are certain data to be collected and submitted for all evaluation sites regardless of kind of rock.

1. Materials at the borrow source should be described in detail as to: hardness number, composition, structure, plasticity of minus No. 40 fraction, water stability (slaking reaction) if applicable, mode of deposition of origin. Note: These data should be available from investigational reports on future sites selected for evaluation.

2. An engineering report will be prepared and provide detailed narrative description of:

a. Equipment used and methods employed in ripping, loading, hauling, wetting or drying, and mechanical processing operations such as raking, blading, discing. The effects of these various operations on the characteristics of materials should be described, i.e. - The shale ripped easily using a D-7 caterpillar tractor with most chunks or slabs less than 12" maximum dimension. It was difficult to rake out materials larger than 6" without removing a significant amount of finer materials.

b. Compacting equipment and methods giving type, weight, and speed of equipment; thickness of lift; number of passes per lift; and difficulties encountered in the compaction process.

B. Specific procedures to be followed for various kinds of material.

Group I - Durable Rock:

I-A - Material with more than 65% passing No. 4 sieve. No evaluation studies are recommended for these materials.

I-B - Materials with 35-65% passing No. 4 sieve.

a. The engineer will collect three 50 to 100 pound samples of materials as it is dumped on the fill (prior to spreading, raking, etc.) at 3 different locations and elevations for each borrow source to be studied on the site.

b. Samples collected in (a) above will be screened on a 3" sieve. The moist weight of material larger than 3" should be determined for the following fractions: larger than 3" but smaller than 6", larger than 6" but smaller than 9", and larger than 9".

All material smaller than 3" with 2 or 3 representative rocks larger than 3" should be sent to the laboratory in moisture-proof bags. The plus 3" rocks will be used to determine moisture content.

c. Moisture-density tests to determine mass density and density of the minus 3/4" fraction of the compacted embankment will be made at the same locations represented by the 3 samples described in (a).

d. A 50-pound sample should be collected for laboratory testing from the area surrounding the test hole used for the embankment density determination. Care should be exercised to prevent contamination of this sample with sand used for the density test. The sample taken adjacent to the density test hole should contain nothing larger than the largest particle occurring in the density test material.

I-C - Material with less than 35% passing No. 4 sieve.

a. The moisture content and mass density should be determined on compacted embankments or rock fills where materials have D_{95} size of 6" or less.

b. Gradation characteristics should be determined for the total sample. The amount of material larger than 3" should be determined on the site. The amount and gradation of material smaller than 3" can be determined on-site or the sample can be sent to the laboratory for analyses.

c. Moisture-density tests will be difficult to perform on this type of material. The number of tests should be limited to that required for representation of material gradation and usage.

Group II - Moderately Durable, Degrading Rock:

The evaluation of behavior characteristics of these materials on the basis of gradation (IIA, IIB, IIC) is not significant except in typing the compacted end product. The gradation of the compacted material may be an important factor in establishing specifications and construction procedures.

Manipulating and processing operations alter the basic gradation characteristics of these materials. It is important, therefore, that gradation characteristics be determined at various stages of construction so that degrees of degradation or breakdown can be related to specific construction operations.

Procedures recommended are as follows:

a. Material at borrow source.

1. A complete description of borrow operations should be prepared. This would include details on ripping, loading, and hauling.

2. A rough determination should be made of the size characteristics of the material as it is loaded. This would include approximate maximum size and shape of particles, and relative distribution of particle sizes in the mass. This determination should be made for each kind of material where different kinds are distinguishable in the excavating and loading processes.

After material has been dumped on the fill, studies to determine degradation due to various operations will be carried on at 3 to 6 individual locations on the embankment. All information and samples for each location should be collected from the same immediate area and elevation on the fill.

The following data and samples will be collected for each test location on the fill. Each test location should be tied to materials and information supplied in items (a) above.

b. Material "as dumped on the fill."

1. The gradation of the material larger than No. 4 sieve (moist weight basis) should be determined in the field.

2. A 25-50 pound sample of material between 1" and 6" sizes should be submitted to the laboratory.

c. Material after processing (grading, raking, watering, discing, etc.) but prior to compaction.

1. The gradation of material larger than No. 4 sieve (moist weight basis) should be determined in the field.

2. A 50-pound sample of material smaller than 3" should be submitted to the laboratory.

d. Material after compaction.

1. A moisture-density test should be performed on the compacted fill to determine the inplace density of (a) the total mass, (b) the fraction smaller than 3/4", and (c) the fraction smaller than the No. 4 sieve.

2. Gradation of the density test material larger than No. 4 should be determined on site.

3. Material smaller than No. 4 sieve collected from the density test should be submitted to the laboratory.

4. An undisturbed sample consisting of 5" or more diameter core or 1 cubic foot hand cut clod should be submitted to the laboratory.

Group III - Non-Durable, Soft Degrading Rock:

It is not practical and generally not physically possible to determine the basic gradation characteristics of this type material. Any manipulating or processing operation changes the gradation. It is important, however, to evaluate processes and work required to obtain the desired product.

Recommended procedure is as follows:

a. Material at borrow source.

Detailed descriptions should be prepared covering material behavior in the borrow source as it is excavated, loaded, and hauled. Evaluating breakdown of these materials at this stage of construction is important.

b. Material as dumped on fill.

1. A rough gradation of the plus No. 4 material based on moist weights should be determined as the material is dumped on the fill. Fractions determined should be: passing No. 4; larger than No. 4 - smaller than 3/4"; larger than 3/4" - smaller than 1-1/2"; larger than1-1/2" - smaller than 3"; and larger than 3".

2. A 300-pound sample of minus 6" material, as dumped, should be submitted to the laboratory for each significant kind of material (soft sandstone and shale may occur in same formation).

c. Material after compaction.

1. Three to six tests should be performed to determine moisture content and mass density of compacted embankment. These tests should be located at various stations and elevations of the fill and must be located in areas of material represented by the sample described in item (b 2) above.

2. Undisturbed samples should be collected immediately adjacent to the exact location of the moisture-density tests performed on the compacted fill. These samples may be cores of 5" or more diameter or hand cut blocks at least 1 cubic foot in size.

III. Provisions should be made to collect undisturbed cores at regular intervals for the next 10 years from completed dams covered by the above evaluation studies on Group II and III materials. Cores should be collected from the same location and elevation previously sampled in the structures. These cores will be used to evaluate the long time durability and weathering characteristics of shale and similar materials.

IV. Reports and Data:

It is important that all reports, data, samples, etc., prepared and collected as a part of these evaluation studies be systematically identified. Identification should include the following information.

1. State, project, and site number.

2. Material type.

3. State of material - "at borrow source," "as dumped," "after processing and ready for compacting," "after compacting."

4. Test location, show centerline station number, offset from centerline, distance R or L, and elevation top of lift.

A proposed "Gradation Data Sheet" is attached.

It should be recognized that several data sheets will be involved for each test location. For example Site X, test location No. 1, may have field gradation tests data on material as dumped, after processing, and after compaction, and moisture-density test data after compaction. It will be important to establish an adequate filing and reference system for these data.

GRADATION DATA SHEET

State:_____ Project:_____ Site:_____

Evaluation Study and Sample No.:_____ Material Type:_____

Material Tested:[1]/_____

Size	(1) Weight ( ) Moist ( ) Dry Pounds	(2) Percent Of Total Sample	(3) Accumulative Percent Smaller Than	(4) Accumulative Percent Of Fraction < 3" or < D_{95} [2]/
> 12"				
<12" > 9"				
<9" > 6"				
<6" > 3"				
<3" > 1-1/2"				
<1-1/2" > 3/4"				
<3/4" > No. 4				
<No. 4				[3]/
TOTAL	lbs.	100%		

Remarks: (Moisture content if determined, etc.)_____

_____

_____

1/ Describe as "at borrow source," "dumped on fill," "before" or "after processing prior to compacting," "after compacting," etc.

2/ For classification, Type

(a). 100% - Minus 3" fraction when total sample is < 3".
(b). 100% - Minus D_{95} fraction when sample contains particles 3" and larger.

3/ Material Type Criteria.

SOILS WITH MORE THAN 5% GRAVEL

		Gradation	Construction Control	Testing	Design and Specification	Sample Size
Group I - Rock is Durable, Hard, Water Stable	Low Placticity Soil Fraction	> 65% < #4	< #4	<#4	<#4	50 lbs.
		35%-65% <#4	Mass or <3/4"	Mass or <3/4"	Mass or <3/4"	250 lbs.
		< 35% <#4	Method that will produce desired density.	Usually none	Mass density	250 lbs. (if required)
	Plastic Soil Fraction	Same as low plasticity matrices except that density tests may be limited when gravel contents approach 35%.				
Group II - Rock is Moderately Durable and can be separated from soil		> 65% <#4	<#4	<#4	<#4	300 lbs.
		35%-65% <#4	Mass (Breakdown if specified)	Mass	Mass (Breakdown if needed)	
		< 35% <#4	Method that will produce desired density	Usually none	Mass density	300 lbs. (If required
Group III - Soft Rock, Unstable in Water			Mass density	Mass density	Mass density	150 lbs.